FAA SPACE WEATHER EFFECTS

Living with a Star Measurement Requirements Workshop

February 9, 2000

Lt Col Erwin Williams
Weather Standards Division
Aviation Weather Directorate

OVERVIEW

- Spectrum Policy and Management (ASR)
  - Space Environment Center (SEC) Products Used
  - Action Taken
  - Space Weather Shortfalls
- Civil Aeromedical Institute (CAMI)
  - SEC Products Used
  - Actions Taken
  - Space Weather Shortfalls
  - Aircraft Space Weather Regulations/Awareness
- Future FAA Space Weather Actions

SPECTRUM POLICY AND MANAGEMENT (ASR)

- SEC Products Used
  - Alerts and Warnings
  - Daily 100-245 MHz Summary
- Action Taken
  - If electron event $\geq$ 1000 pfu, PRIORITY message sent to all FAA centers/regions stating HF, VHF, UHF, and SATCOM may experience interference for next 72 hours
    -- Used to help troubleshoot possible comm outages
- Space Weather Shortfalls: None

**********URGENT**********

From NOAA Space Environment Center, Space Weather Office

To Oscar Alvarez
Federal Aviation Administration
Phone 202-267-7531

****

The Center has issued the following Warnings or Alert(s) at 14:42UT
on 7 Feb 2000

Alert Code SWXALTEF3 Serial Number 207
Electron Event >=1000pfu @ >2MeV BEG 7 Feb 2000 14:25 UT
Comment:
None

For more information on this Warning or Alert call the Space Weather
Office at (30.) 497 3171 (24 Hours) or email swo@sec.noaa.gov

To modify your request for our products call the Space Environment Center
at (303) 497 3214 (8am - 5pm Mountain Time) or email ccurtiss@sec.noaa.gov

TELEGRAPHIC MESSAGE

NAME OF AGENCY	PRECEDENCE	SECURITY CLASSIFICATION
DOT/FAA/ASR	ACTION: PRIORITY INFO: PRIORITY	
ACCOUNTING CLASSIFICATION	DATE PREPARED DECEMBER 9, 1999	FILE

FOR INFORMATION CALL		TYPE OF MESSAGE
NAME BLANCHE MADER	PHONE NUMBER 267-9733	☐ SINGLE ☐ BOOK ☐ MULTIPLE-ADDRESS

THIS SPACE FOR USE OF COMMUNICATION UNIT

MESSAGE TO BE TRANSMITTED *(Use double spacing and all capital letters)*

TO: KDONYYYX

RADIO GENOT NR. 9/58

ATTN: ALRCN 200/400 ALARTC ALAFFO

SOLAR MAGNETIC ACTIVITY OBSERVED DECEMBER 9, 1999.

HF, VHF, UHF AND SATELLITE COMMUNICATIONS MAY EXPERIENCE

INTERFERENCE FOR THE NEXT 72 HOURS.

[illegible] SIGNED BY
GEORGE K. SAKAI
for GERALD J. MARKEY
ASR-1

DATE TIME GROUP
10 DEC 1999 13 [illegible] 26

SECURITY CLASSIFICATION	PAGE NO.	NO. OF PGS.
	1	1

CIVIL AEROMEDICAL INSTITUTE (CAMI)

- SEC Products Used
  - Alerts and Warnings
  - GOES solar energetic particle data
  - Consultation on solar particle radiation events
- Actions Taken
  - If solar flare causes a biologically important increase in the ionizing radiation at aircraft altitudes, radiation levels are reported at CAMI Web site:

    http://www.cami.jccbi.gov/AAM-600/610/600Radio.html

CIVIL AEROMEDICAL INSTITUTE (CAMI) (cont.)

- Actions Taken (cont.)
  - Each month, updates a heliocentric potential (megavolts) value to enable CARI to adjust for effect the solar wind has on galactic cosmic radiation (1 month lag in availability of updated values)
    -- CARI: free s/w available from CAMI Web site
      --- Calculates effective dose of galactic cosmic radiation received on individual nonstop aircraft flights during any month from Jan 58 to the present
      --- Takes into account the effects of the solar activity cycle and the geomagnetic field

Federal Air Surgeon's *Medical Bulletin*, Spring 99

A Computer Program for Calculating Flight Radiation Dose

Wallace Friedberg, PhD

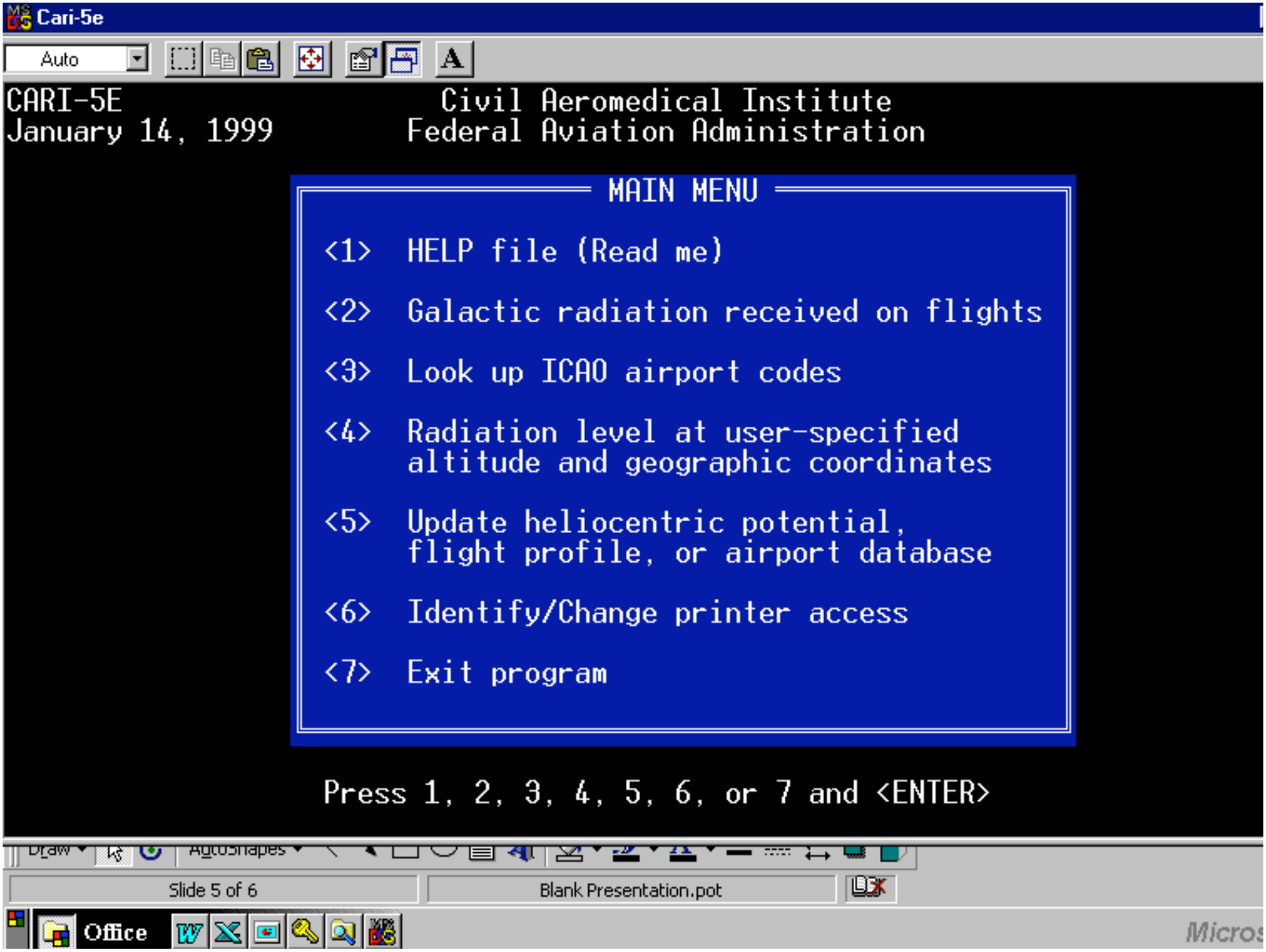
Aircraft crews are exposed to ionizing radiation, principally from galactic cosmic radiation. To promote radiation safety in civil aviation, the Federal Aviation Administration (FAA) has provided instructional material on radiation exposure during air travel (1, 2, 3, 4) based on research performed at the Civil Aeromedical Institute (CAMI).

FAA Advisory Circular 120-61 (4) contains recommended topics for a training program on in-flight radiation exposure to instruct air carrier crewmembers and their managers on the possible health risks from exposure to ionizing radiation and on basic radiation protection principles.

The FAA recently released a computer program developed at CAMI called CARI-5E*. The program estimates the galactic radiation dose received on an aircraft flying a great circle route between any two airports in the world. In calculating flight dose, CARI-5E takes into account the location of the aircraft during the entire flight from takeoff to touchdown, including enroute altitudes; time spent at each enroute altitude, and latitude and longitude changes. Based on the date entered by the user, the appropriate databases are accessed for (a) the approximate 11-year cycle of rise and decline in radiation level in the atmosphere associated with changes in solar activity and (b) the characteristics of the earth's magnetic field that influence the galactic radiation entering the atmosphere at the time of the flight.

The program is available from the Radiobiology Research Team's home page found at the CAMI Website: www.cami.jccbi.gov/AAM-600/610/600Radio.html

**Editor's note: The CARI-5E program was developed under Dr. Friedberg's leadership.*


Cari-5e
Auto
CARI-5E
January 14, 1999
Civil Aeromedical Institute
Federal Aviation Administration
MAIN MENU
<1> HELP file (Read me)
<2> Galactic radiation received on flights
<3> Look up ICAO airport codes
<4> Radiation level at user-specified altitude and geographic coordinates
<5> Update heliocentric potential, flight profile, or airport database
<6> Identify/Change printer access
<7> Exit program
Press 1, 2, 3, 4, 5, 6, or 7 and <ENTER>
Draw
AutoShapes
Slide 5 of 6
Blank Presentation.pot
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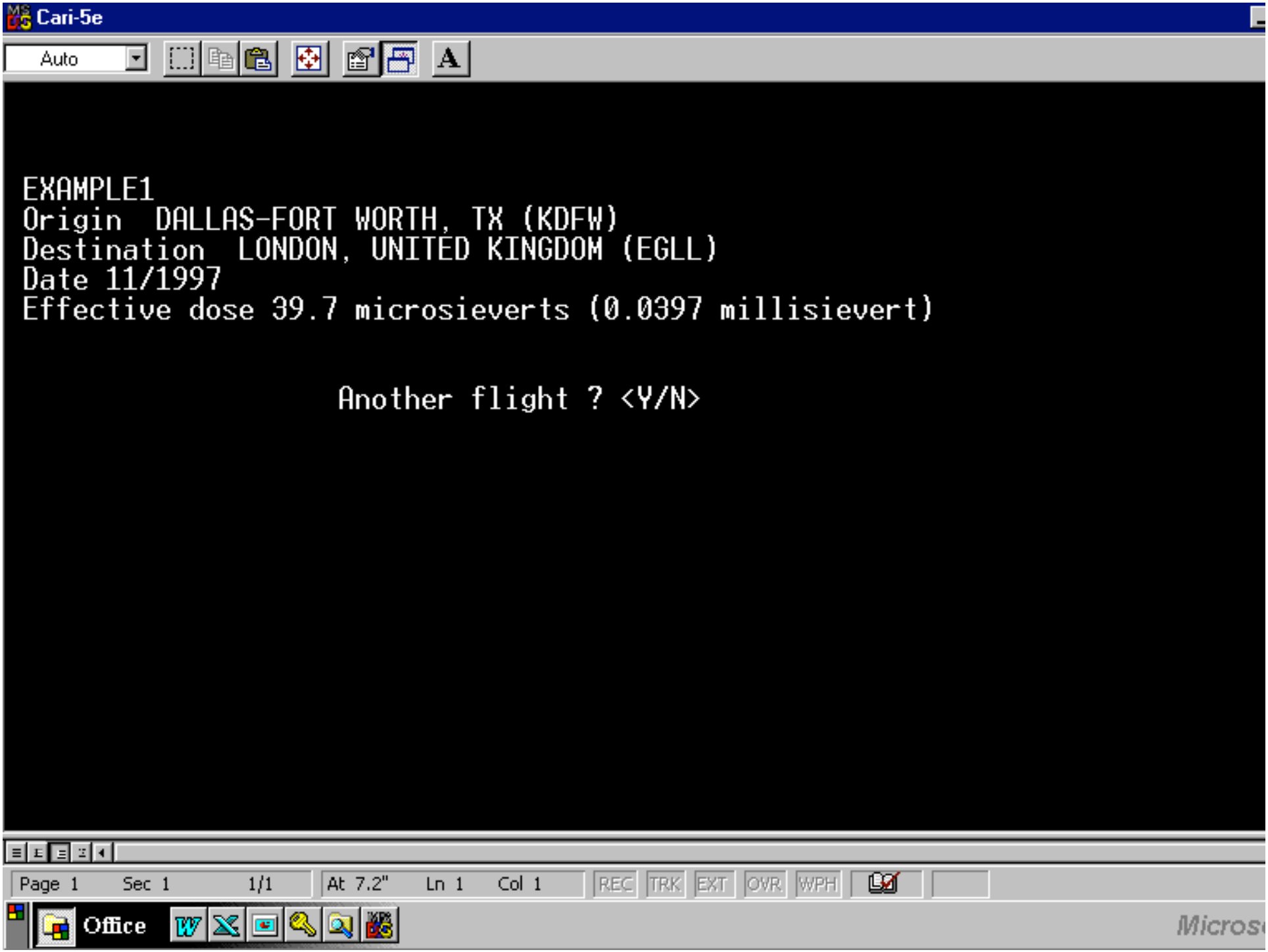
Cari-5e
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EXAMPLE1
Origin DALLAS-FORT WORTH, TX (KDFW)
Destination LONDON, UNITED KINGDOM (EGLL)
Date 11/1997
Effective dose 39.7 microsieverts (0.0397 millisievert)
Another flight ? <Y/N>
Page 1 Sec 1 1/1
At 7.2" Ln 1 Col 1
REC TRK EXT OVR WPH
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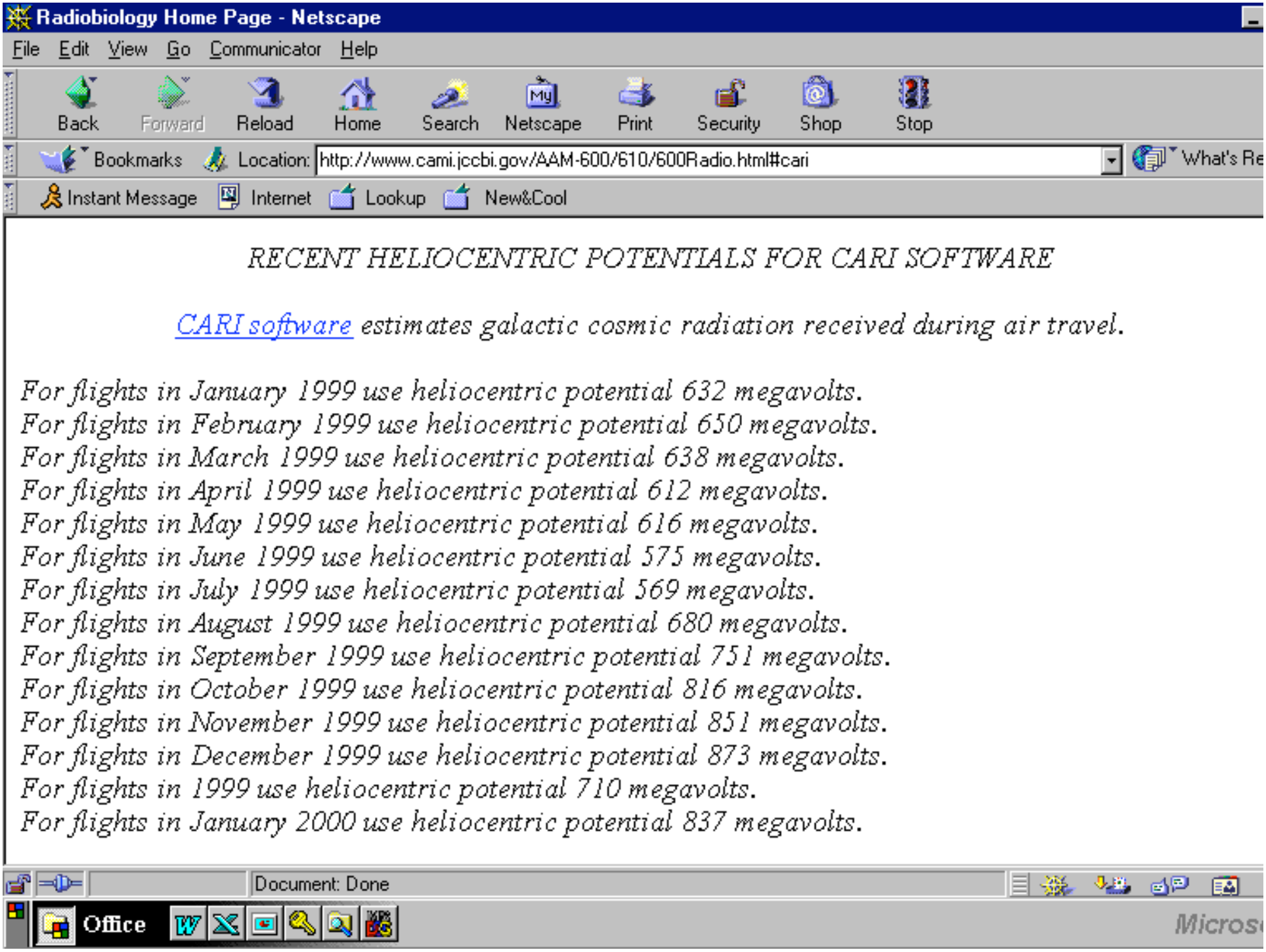
Radiobiology Home Page - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print Security Shop Stop
Bookmarks Location: http://www.cami.jccbi.gov/AAM-600/610/600Radio.html#cari
Instant Message Internet Lookup New&Cool
RECENT HELIOCENTRIC POTENTIALS FOR CARI SOFTWARE
CARI software estimates galactic cosmic radiation received during air travel.
For flights in January 1999 use heliocentric potential 632 megavolts.
For flights in February 1999 use heliocentric potential 650 megavolts.
For flights in March 1999 use heliocentric potential 638 megavolts.
For flights in April 1999 use heliocentric potential 612 megavolts.
For flights in May 1999 use heliocentric potential 616 megavolts.
For flights in June 1999 use heliocentric potential 575 megavolts.
For flights in July 1999 use heliocentric potential 569 megavolts.
For flights in August 1999 use heliocentric potential 680 megavolts.
For flights in September 1999 use heliocentric potential 751 megavolts.
For flights in October 1999 use heliocentric potential 816 megavolts.
For flights in November 1999 use heliocentric potential 851 megavolts.
For flights in December 1999 use heliocentric potential 873 megavolts.
For flights in 1999 use heliocentric potential 710 megavolts.
For flights in January 2000 use heliocentric potential 837 megavolts.
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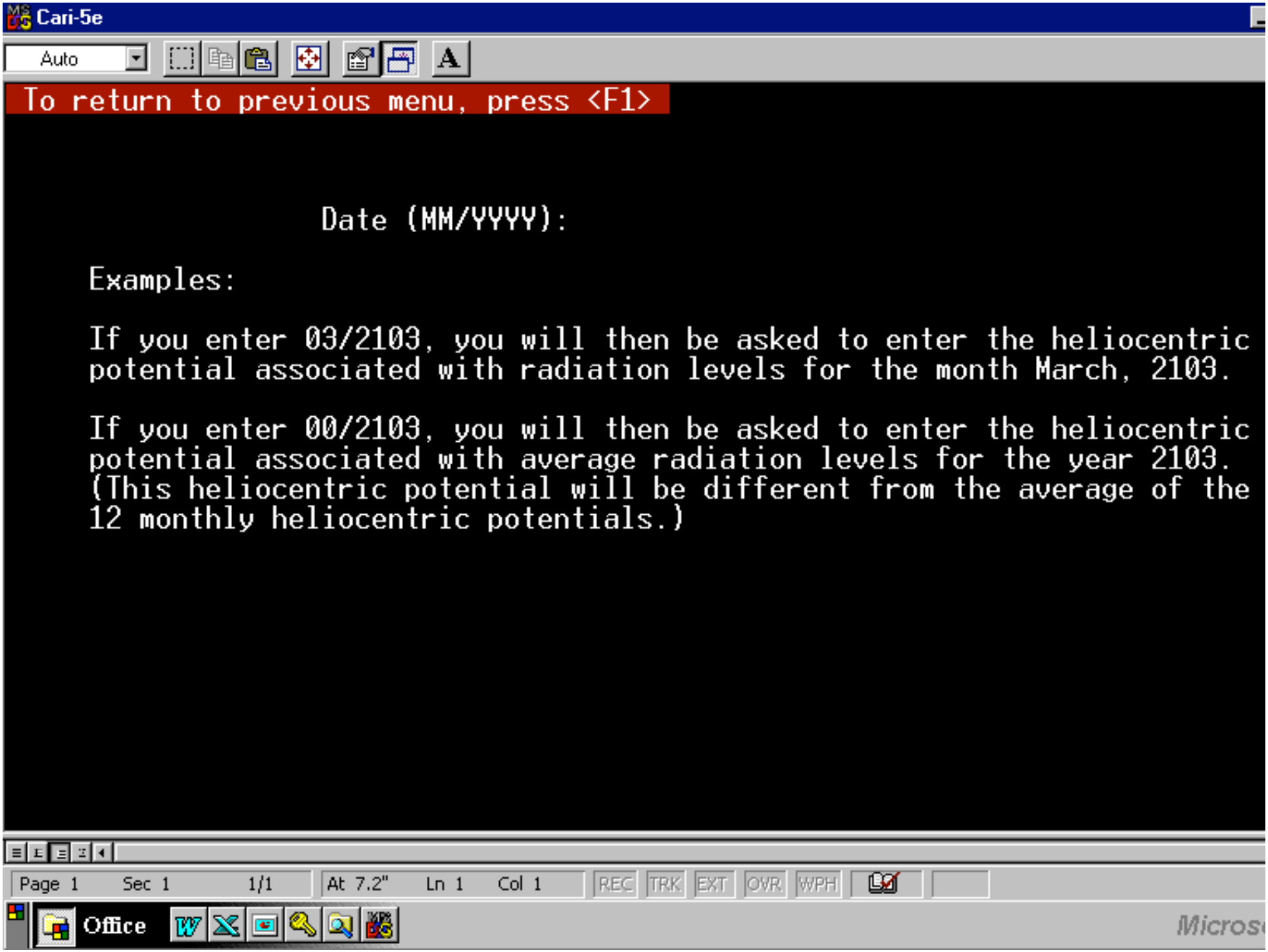
Office


Cari-5e
Auto
To return to previous menu, press <F1>
Date (MM/YYYY):
Examples:
If you enter 03/2103, you will then be asked to enter the heliocentric potential associated with radiation levels for the month March, 2103.
If you enter 00/2103, you will then be asked to enter the heliocentric potential associated with average radiation levels for the year 2103. (This heliocentric potential will be different from the average of the 12 monthly heliocentric potentials.)
Page 1 Sec 1 1/1
At 7.2" Ln 1 Col 1
REC TRK EXT OVR WPH
Office

CIVIL AEROMEDICAL INSTITUTE (CAMI) (cont.)

-- CARI: free s/w available from CAMI Web site (cont.)
  --- Used by
    ---- European Union air carriers
    ---- $\geq$ 30 scientists worldwide (Japan, China, Australia, etc.)
    ---- Individual airline personnel (e.g.,pilots, attendants)
    ---- USAF

CIVIL AEROMEDICAL INSTITUTE (CAMI) (cont.)

- Space Weather Shortfalls
  - Real-time notification of solar events--currently lag by several hours
    - -- Neutron count at ground level
    - -- Proton fluxes from GOES satellites
  - SEC Web site to post proton levels $\geq$ 1000 MeV
    - -- Currently cuts off at 100 MeV

CIVIL AEROMEDICAL INSTITUTE (CAMI) (cont.)

- Aircraft Space Weather Regulations/Awareness
  - No FAA regulations on airline personnel radiation exposure or education
    - -- FAA Advisory Circular 120-61, Crewmember Training on In-flight Radiation Exposure (2 pp), http://www.faa.gov/avr/afs/radiation.doc
      - --- Recommends air carrier personnel education
      - --- CAMI assisted American Airlines in writing/updating Radiation Exposure Advisory booklet

ADVISORY CIRCULAR

Subject: **Date: 5/19/94** **AC no.120-61**
Initiated by: AFS-200

CREWMEMBER TRAINING ON
IN-FLIGHT RADIATION EXPOSURE

1. PURPOSE. The purpose of this Advisory Circular (AC) is to recommend subjects to be covered in air carrier programs designed to: (1) inform crewmembers about radiation exposure and known associated health risks; and (2) assist crewmembers in making informed decisions with regard to their work on commercial air carriers. While the AC provides a possible outline of courses, actual subject material should be gathered by the air carriers.

2. BACKGROUND. Air carrier crewmembers are occupationally exposed to low doses of ionizing radiation from cosmic radiation and from air shipments of radioactive materials. In a Presidential document, "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," 52 Fed. Reg. 2822-2834 (1987), it is recommended that workers occupationally exposed to ionizing radiation, and managers of these activities, receive instruction on possible health effects associated with such exposure and appropriate radiation protection practices. The Federal Aviation Administration (FAA) has provided information concerning in-flight radiation in the Office of Aviation Medicine report No. DOT/FAA/AM-92-2, "Radiation Exposure of Air Carrier Crewmembers." This document is available through the National Technical Information Service, Springfield Virginia 22162.

3. DISCUSSION. It is recommended that the following topics be covered to inform crewmembers about radiation exposure. These topics need not be covered in this order, although this is one logical sequence:

a. Types and amounts of radiation received during air travel, as well as comparisons with other sources of exposure, e.g., radon exposure in the home and medical x-rays.

b. Variables that have an effect on the amount of radiation exposure in flight (such as altitude, latitude, and solar flares).

c. Guidelines regarding exposure to ionizing radiation, including recommended limits for workers and the general public.

d. The risks to crewmembers and fetuses associated with exposure to cosmic radiation include:

CIVIL AEROMEDICAL INSTITUTE (CAMI) (cont.)

- Aircraft Space Weather Regulations/Awareness (cont.)
  - -- FAA AC 120-52, Radiation Exposure of Air Carrier Crewmembers (12 pp), http://www.bts.gov/ntl/DOCS/Ac12052.html
    - --- Information on radiation types
    - --- Exposure guidelines
    - --- Estimates of radiation exposure
    - --- Estimated health risks

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: RADIATION EXPOSURE OF AIR CARRIER CREWMEMBERS

Date: March 5, 1990 **AC No:** 120-52
Initiated by: AAM-624 **Change:**

1. PURPOSE. This circular provides (a) information on cosmic radiation and on air shipments of radioactive material as sources of ionizing radiation[1] exposure during air travel; (b) guidelines for exposure to radiation; (c) estimates of the amounts of galactic cosmic radiation received on air carrier flights on various routes to and from, or within, the contiguous United States (table 1); and (d) example calculations for estimating health risks from exposure to galactic cosmic radiation.

2. GENERAL. Ionizing radiation has always been part of the human environment. Sources of such radiation are the radionuclides (radioactive atoms) in our bodies and in the earth, and the cosmic radiation in the atmosphere. We are also exposed to ionizing radiation during some medical and dental procedures. Table 2 shows average dose equivalent[2] rates from various sources of ionizing radiation encountered in the United States.

Air travelers are exposed to cosmic radiation levels that are higher than the cosmic plus terrestrial radiation levels normally encountered on the ground. In the contiguous United States at ground level the average dose equivalent rate from cosmic plus terrestrial radiation is 0.06 microsievert (0.006 millirem) per hour (NCRP 1987b). At an altitude of 35,000 feet, for example, the dose equivalent rate from cosmic rays is about 6 microsieverts (0.6 millirem) per hour (O'Brien 1978, as revised).

Another source of radiation exposure during air travel is air shipments of radioactive material -- mostly radiopharmaceuticals used in medical diagnosis and treatment.

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[1] Ionizing radiation is so named because each of its units has sufficient energy to eject an orbital electron from an atom and thus produce an ion (electrically charged atom or group of atoms). Examples of ionizing radiation are cosmic ray particles and x-ray or gamma-ray photons.

[2] Dose equivalent is a measure of the biological harmfulness of ionizing radiation and takes into account the fact that equal amounts of absorbed energy from different types of ionizing radiation are not necessarily equally harmful. The present international unit of dose equivalent is the sievert. The sievert replaces the rem; 1 sievert = 100 rem.

1000 millisieverts = 1 sievert;
1000 microsieverts = 1 millisievert.

CIVIL AEROMEDICAL INSTITUTE (CAMI) (cont.)

- Aircraft Space Weather Regulations/Awareness (cont.)
  - European Union regulations to take effect ~ May 00 will require all 27 EU carriers to provide personnel education and dose assessments
  - Public awareness increasing--e.g., CNN report, "Frequent fliers exposed to elevated radiation levels," http://cnn.com/2000/TRAVEL/NEWS/02/03/airlines.radiation.reut/index.html

CNN - TravelGuide - Frequent fliers exposed to higher-than-normal radiation - Feb. 3, 2000 - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Netsite: http://cnn.com/2000/TRAVEL/NEWS/02/03/airlines.radiation.reut/index.html

Instant Message Internet Lookup New&Cool

Frequent fliers exposed to elevated radiation levels

Experts say risks low, but real

February 3, 2000
Web posted at: 4:04 p.m. EST (2104 GMT)

NEW YORK (Reuters) -- For years, airline passengers have been calling ahead to check on weather delays. Soon they may also be calling to find out about radiation levels.

"Radiation levels are significantly elevated and you should seriously consider postponing your trip" is one recording on the 1-877 SUNFLARE hotline established by Dr. Robert Barish, founder of In-Flight Radiation Protection Services Inc., which informs callers about possible health risks and at what times solar storms cause radiation peaks.

Radiation from sun exposure is a usually harmless fact of life for people on the ground but it can be harmful for people who fly at high altitudes during solar storm peaks.

The storms occur on an irregular basis but their frequency is expected to reach a peak this year. They can cause radiation levels to reach the equivalent of 100-200 chest X-rays an

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FUTURE FAA SPACE WEATHER ACTIONS

- Identify users and systems that could benefit from automated product/data delivery: 1CY01-3CY01
- Identify communications standardization issues for dissemination and data transfer: 2CY00-3CY00
- . Determine priority list of user needs for space weather information to guide resource allocation: 1CY01-1CY02
- Identify users who could benefit from local data ingest and/or local data processing: 1CY01-3CY01

FUTURE FAA SPACE WEATHER ACTIONS (cont.)

- Characterize impact of space weather on user programs and prioritize data/product needs: 1CY01-1CY03
- Improve customer feedback on product utility and improvement: 2CY00-2CY00
- Establish strong interface with System Program Offices (SPOs)/designers: 1CY01-1CY03